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HOW THE LANGUAGE OF KINDERGARTEN CHILDREN MAY BE DEVELOPED FOR USE IN PROBLEM SOLVING.

MCNEANY, ROBERT * KEISLAR, EVAN R.
BVE08490 UNIVERSITY OF CALIFORNIA, LOS ANGELES CAMPUS

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*LANGUAGE DEVELOPMENT, *PROBLEM SOLVING, *KINDERGARTEN CHILDREN, *TASK PERFORMANCE, *VERBAL ABILITY, COMPARATIVE ANALYSIS, LOW INCOME GROUPS, ELECTROMECHANICAL AIDS, INSTRUCTIONAL AIDS, LOS ANGELES, CALIFORNIA

THE VALUE OF YOUNG CHILDREN VOCALIZING DURING A PROBLEM-SOLVING TASK WAS STUDIED. IN A 2-DAY INVESTIGATION, SIXTY 4-YEAR-OLD CHILDREN WERE TRAINED INDIVIDUALLY TO SELECT THE CORRECT ONE OF THREE PICTURES DIFFERING ONLY IN SIZE. THE CHILDREN WERE DIVIDED RANDOMLY INTO A LABELING GROUP AND A NONLABELING GROUP. CHILDREN IN THE LABELING GROUP WERE REQUIRED TO OVERTLY VERBALIZE RELEVANT LABELS DURING THIS SELECTIVE LEARNING TASK. THEY PERFORMED SIGNIFICANTLY BETTER DURING TRAINING AND ON A POST-TEST THAN CHILDREN WHO SAW THE SAME STIMULI BUT WERE GIVEN NO LABELING TRANING. THIS FINDING WAS NOT VERIFIED IN AN 8-DAY INVESTIGATION WHERE THE PRESENTATION OF STIMULUS MATERIALS AND VERBAL INSTRUCTIONS WAS ELECTRONICALLY CONTROLLED. SEVENTY-TWO 5-YEAR-OLD CHILDREN WERE DIVIDED RANDOMLY BETWEEN LABELING AND NONLABELING GROUPS AND GIVEN TRAINING ON A SELECTIVE LEARNING TASK INVOLVING MATERIALS DIFFERING IN SIZE, THICKNESS, LENGTH, AND COLOR VALUE. CHILDREN IN THE LABELING GROUP WERE REQUIRED TO LEARN FOUR SETS OF RELEVANT LABELS. ON THE POST-TEST, WHERE NO CHILDREN WERE INSTRUCTED TO VERBALIZE, NO DIFFERENCES IN PERFORMANCE WERE FOUND BETWEEN THE LABELING AND NONLABELING GROUPS. ALL CHILDREN PERFORMED CONSISTENTLY WORSE WHEN THE INTERMEDIATE SIZE PICTURE WAS THE CORRECT STIMULUS. A PILOT STUDY ALSO DEMONSTRATED THE POSSIBLE INTERFERING EFFECTS OF LANGUAGE. (RS)

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Robert McNeany and
Evan R. Keislar

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University of California

Los Angeles, California

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INTRODUCTION

Problem

The central problem faced by this investigation is how children in kindergarten may best be helped in their emerging ability to use language in problem solving.

There is a growing body of evidence that suggests that ages from four to seven are critically important with respect to language development. Prior to this period the child has acquired an ability in using language to get what he wants (manding). He is also well started toward speaking in order to supply information to others (tacting). From the point of view of education, a most important function of language is acquired when the individual uses his own verbal responses to talk to himself. It is this self-cueing function which appears to develop very rapidly during this period. Kuenne (16, p.488) concluded that there seems to be a stage in development where "...the child is able to make differential verbal responses to appropriate aspects of the situation, but this verbalization does not control or influence his overt choice behavior." This conclusion is shared by a number of other researchers (13; 17).

Four-year-old children do much better in problem solving when they are instructed to talk out loud as they work. Seven-year-old children, on the other hand, have learned so well to respond to their own speech that their problem-solving behavior is unaffected by instructions to talk out loud (12).

The major self-cueing function of language is not an ability which suddenly emerges to make man a rational creature. As Reese (23, p.507) has suggested, "The critical age for the occurrence of mediation may be different for different experimental situations and for different concepts." Yet, just how is this ability to talk to oneself brought about? Does the child "accidentally discover" that he should start paying attention to his own speech?

Jensen (8) suggests that the self-cueing function of words is not learned as well by children who are raised in a language deprived environment. There may be many areas of our own culture where even normal children do not receive the kind of language training which would most help them develop this important function.

It is the assumption of this investigation that, even without a more adequate understanding of the verbal mediation process, it would be fruitful to explore the possibilities of helping five-year-old children to improve this ability in a limited field. Fundamental research in this area may reveal not only that it is possible to teach children such learning processes at an earlier age, but that it is desirable to introduce this type of early instruction. Leaving such developments to chance effects from culture may result in "faulty habits" of thinking and learning that may be difficult to alter later on in school. Fowler (5) suggests that such learning may be better established early than later.

Review of Related Research

Inferential behavior in children has been studied by Kendler (14). In these problems self-cueing is clearly important. Although she reports that inferential behavior, "the capacity to combine independently acquired habit segments," is found in few youngsters below the age of six, it should be noted that Kendler's study involved usually a single session.

As Kendler's definition suggests, inferential behavior consists of combining two learnings acquired separately; it means putting "two and two together" to yield novel behavior. This is what the phenomenon of mediated generalization involves. Birge's (2) study demonstrated that preschool children could use the names of objects and not their appearance as a basis for generalization to a new situation. This would put the segments A-B and B-C together to form an entirely new A-C behavior where the word B was the mediator. However, mediated generalization represents a phenomenon which is not necessarily a logical one; there is evidence that mediators on occasion create interference (i.e. invalid inferential behavior). Kendler and Kendler (12) for example, found

that seven-year-old children, who are instructed to say irrelevant generalizations out loud, are hindered more than four-year-olds who are given the same instructions. The older children because they are responding to their own words, find these self-cues non-functioning.

The large number of studies which have been carried out on children's use of mediation have yielded conflicting results. These conflicting results, however, may well be attributed to the fact that these studies were short range investigations. A plausible interpretation of these results suggests that children at these ages are at the brink of being able to engage in mediating behavior in a logical fashion to produce valid inferences.

Keislar and McNeil (11) demonstrated that a good proportion of first-grade children, after three weeks of programmed instruction, can acquire and use verbal generalizations for solving problems relating to science. This stream of research has recently been summarized in relation to mediation (9). Stern (28) found that active rehearsal of concept names facilitated later performance of kindergarten and first-grade children on a concept-identification task; presumably the concept names were more readily available to the children as mediators. After five years of research in the teaching of French, Keislar and Mace (10) concluded that with young children the overt speaking response played a critical role.

Studies have found that children learn to discriminate among stimuli more rapidly if they attach a verbal response to the stimuli during training (21; 24). Other research indicates that discriminations between similar appearing stimuli are easier if names applied to forms are distinctive than if names are similar (4; 18). Jeffrey (7) found verbal mediators to be superior to motor mediators in producing mediation in young children. Weir and Stevenson (29) report instructions to overtly verbalize the mediators facilitated learning at all age levels; reinforcement of verbal responses was found to result in better learning than reinforcement of motor responses.

Spiker (25) states that verbalization of stimulus names provides response produced stimuli which increase the differences among the stimuli and aid learning by increasing the number of stimuli to which a discriminative response becomes attached. He found that instructions for naming stimuli used in a delayed reaction experiment facilitated performance. Spiker (25, p.67) noted "...many of the Ss who had been taught the names 'bridged' the delay interval by saying aloud the names of the stimulus which they selected following the delay interval." Spiker (25) concluded that the learning of discriminal verbal responses to stimuli facilitates learning motor responses to the same stimuli.

Studies by Norcross and Spiker (19) and Cantor (3) found possession of verbal labels for the stimuli in a learning task to facilitate. One explanation of this facilitation is the mediation hypothesis. This is discussed by Wittrock (30, p.6) who states: "By adding a verbal stimulus to a class of stimulus objects, the members of the class may become more similar to one another and also less similar to stimuli outside the class. The new similarity within the class generalizes to new members of the class to which the verbal label applies."

Several studies have explored young children's ability to discriminate the intermediate size of three stimuli. Hicks and Steward (6) studied transposition in young children. They presented the child with three different sized boxes and reinforced the child's selection of the middle-size box until the child was able to respond correctly. The largest box was replaced by a box smaller than the two other boxes. This process was repeated four times. They found children to confuse the middle-size box with the largest of three boxes twice as often as with the smallest box. They concluded that children selected the middle-size box in relation to the other boxes rather than to a particular box. Reese (22) found five-year-old children to transpose on the near test one step removed, but failing to transpose on the far test; while six-year-olds transposed on both.

In the intermediate size problem, transposition was found to be greater for a group taught to vocalize a

nonsense syllable (27). Price (20) found pretraining with a meaningful relational name to facilitate young children's performance on a transposition test better than pretraining with a nonsense name. Alberts and Ehrenfreund (1) found younger children to verbalize their responses to size as the cue aspect less than older children. They noted that transposition on a size-discrimination problem is more probable when the children have in their vocabulary a relational label with respect to size. Spiker (26) found an understanding of the verbal concept of middle-sizedness facilitated performance on a relational task more than it did on the performance on a nonrelational task. Zeiler (31) noted a constant tendency for the intermediate sized stimulus to be the least preferred of three different sized stimuli.

The role of the overt vocal response was explored in three pilot studies. These pilot studies were designed to throw light on the kinds of problems, the specific type of vocal self-cue, and the general instructional conditions that might be most useful for the major instructional program. The main experiment was designed and carried out in the light of these findings. Pilot Study No. 1 was an effort to determine whether the valid disjunctive argument would offer a type of item for the main experiment. Pilot Study No. 2 explored the possibility of using a logical inference in a story situation. Pilot Study No. 3 investigated the value of teaching the child to use vocal labels in solving problems of a selective learning nature. In previous studies of this field, differences were found between children who had already acquired these verbal responses and those who had not. In contrast, the current investigation used equivalent groups of children, one of whom were taught to say the labels while the other group were not.

PILOT STUDY NO. 1

The Disjunctive Argument With Young Children

Problem

It has been suggested that children from lower socioeconomic class homes have been raised in a language deprived environment (8). In order to determine the kinds of problems that should be adopted for the major instructional program, the performance of young children from a deprived background was studied in terms of the valid disjunctive argument.

Method

Subjects. There were 17 four-year-old children selected at random from the day-care center which they normally attend. These subjects came from lower socio-economic class homes and were predominantly Negro. The average age of the children was 54 months.

Task and Materials. There were 50 white cards, 8 x 10 in. large, on each of which was painted a picture. Through the use of these pictures each subject was individually told ten story problems.

Each problem presented the child with information in the form of the valid disjunctive argument. Every problem bore a close correspondence to the following syllogistic reasoning:

1. Statement P or Statement Q is true.
2. P is false.
3. Therefore, Q is true.

Each problem contained four to six frames. The initial frames presented the information the child needed in order to draw the logical conclusion. The subject was shown a picture of two objects and told that one of these objects was correct. On the next frame he was shown a

picture of one of these objects and told that this object was not the correct one. In the criterion frame which then followed, the child was shown the two objects. He was required to select the correct object by pointing to it. A sample problem of this type is to be found in Appendix A.

Procedure. The child was brought into the experimental room and seated at a small table across from E. Each picture was presented one at a time on a small metal stand placed directly in front of the subject. Instructions given to the child were "We are going to play a game. I am going to show you some pictures that tell a story. At the end of each story, I will ask you a question, so pay attention." On the criterion frame where subjects responded by pointing to one of two possible choices, all responses by the child were reinforced by E saying "good". Subjects were presented with ten story problems as described above. The order of the problems was the same for all children.

Results and Discussion

Out of a maximum possible score of 10 problems correct, the mean score for the seventeen children was 7.4 problems correct. The SD was 2.0. This indicated that four-year-old children from lower socioeconomic class homes do not find simple story problems using the disjunctive argument difficult enough to allow for much improvement. It was therefore decided not to include this kind of problem in the major instructional program.

PILOT STUDY NO. 2

Young Children's Use of Vocalization in Solving Problems Requiring Inferential Thinking

Problem

In this investigation conducted with four- and five-year-old children, the effect was explored of vocalizing a verbal self-cue in the form of complete sentences on problems which require inferential thinking. This information was important in planning the major experiment in order to determine whether a complete sentence should be used as a self-cue instead of a single word or label.

Hypothesis

Children who have been required to say aloud the basic information prerequisite to the drawing of a logical inference (i.e. children who are taught self-cueing) will be more efficient in drawing inferences in similar problem situations than children who see the same visual stimuli and receive the same information, but are not required to produce overtly the relevant statements.

Method

Subjects. There were 10, four-year-old and 8, five-year-old children of normal I.Q. selected at random from day-care centers in Santa Monica. All subjects came from lower socioeconomic class homes.

Task and Materials. There were 48 white cards, 8 x 10 in. large, on each of which was painted a picture. Through use of these pictures each child was individually told nine story-problems. Each problem contained five to seven frames. The problem presented the child with segments of information in the form A-B and B-C. Children were required to put these segments together to form a new A-C chain where the word B was the mediator. This constituted the solution for that problem. A sample

problem is shown in Appendix B.

Procedure. Children were assigned to the Verbal Group or the Non-verbal Group on a random basis. Each child was brought into the experimental room and seated at a small table across from E. The pictures were presented one at a time on a small metal stand placed directly in front of the child. Instructions given to each child were: "We are going to play a game. I am going to show you some pictures that tell a story. At the end of each story, I will ask you a question, so pay attention." Subjects in the Verbal Group were also instructed: "When you hear the word 'repeat', say the next sentence after me." Children in the Verbal Group repeated out loud the B-C segment of information after E. On the criterion frame where subjects responded by pointing to one of three possible choices, all responses by the child were reinforced by E saying "good". Children were presented with nine story problems as described above. The order of the problems was the same for all subjects.

Results

Table 1 shows the difference between the means of the Verbal and Non-verbal Groups to be in favor of the Non-verbal Group. This difference was not in the direction expected. As is indicated in Table 1, the mean number of correct responses for five-year-olds was greater than that of the four-year-old children.

An analysis of variance of the correct responses is shown in Table 2. The Non-verbal Group, which did not vocalize the sentence containing the important inferential information, performed significantly superior to the Verbal Group which did vocalize this statement ($p < .01$). Five-year-old children performed significantly better than did the four-year-olds ($p < .01$).

Discussion

This exploratory study was valuable in deciding the type of self-cue to be used in the major study. The results of this study seem to indicate that the vocalizing of an inferential statement during this type of a story

TABLE 1. Mean Number of Correct Responses on an Inferential Thinking Task for Verbal and Non-verbal Groups.

	Four-year-old Ss			Five-year-old Ss		
	Mean	Stan. Dev.	Mean Diff.	Mean	Stan. Dev.	Mean Diff.
Verbal Group	4.8	.9		7.5	1.0	
Non-verbal Group	6.8	.9	2.0**	8.8	.5	1.3**
Total	5.8	1.1		8.1	.9	

**$p < .01$

TABLE 2. Analysis of Variance of Correct Responses on an Inferential Thinking Task for Verbal and Non-verbal Groups with Two Age Levels.

Source of Variation	SS	df	MS	F
Age (4-yr-old vs. 5-yr-old Ss)	24.0	1	24.0	35.8**
Treatments (Verbal vs. Non-verbal)	11.7	1	11.8	17.6**
Age X treatments	.1	1	.1	
Within cell error	9.3	14	.7	

**$p < .01$

problem produces an interference for young children in the drawing of a logical inference. Children in the Vocal Group seem to have been distracted by being required to vocalize a statement. This distractor was not present for the Non-vocal Group.

PILOT STUDY NO. 3

Young Children's Use of Vocal Labeling Responses on a Selective Learning Task Involving Size

Problem

For the major experiment, it was first necessary to determine the structure of the problems in terms of content, number of frames per problem, and specific type of vocal self-cue. In the previous pilot study, the vocalizing of a verbal self-cue in the form of a complete sentence was not found to facilitate children in problem solving. In this investigation a young child's use of a single word as a cue was explored. This information was important in order to determine whether a short instructional program in the use of relevant labels will significantly enhance a young child's ability to solve a selective learning task.

Hypothesis

On a selective learning task where size is the critical variable, children who have been required to say aloud relevant labels during training will perform better than children who see the same stimuli but are not given labeling training. This superiority will be manifested not only during training but on a posttest.

Method

Subjects. There were 60 four-year-old children selected at random from day-care centers. The subjects came from lower socioeconomic class homes and were predominantly Negro.

Task and Materials. There were 120 white cards, 8 x 5 in. large, 80 of which were used during training and 40 during the posttest. On each card were mounted three pictures which were alike in all respects except that one was large, a second was middle-sized, and a

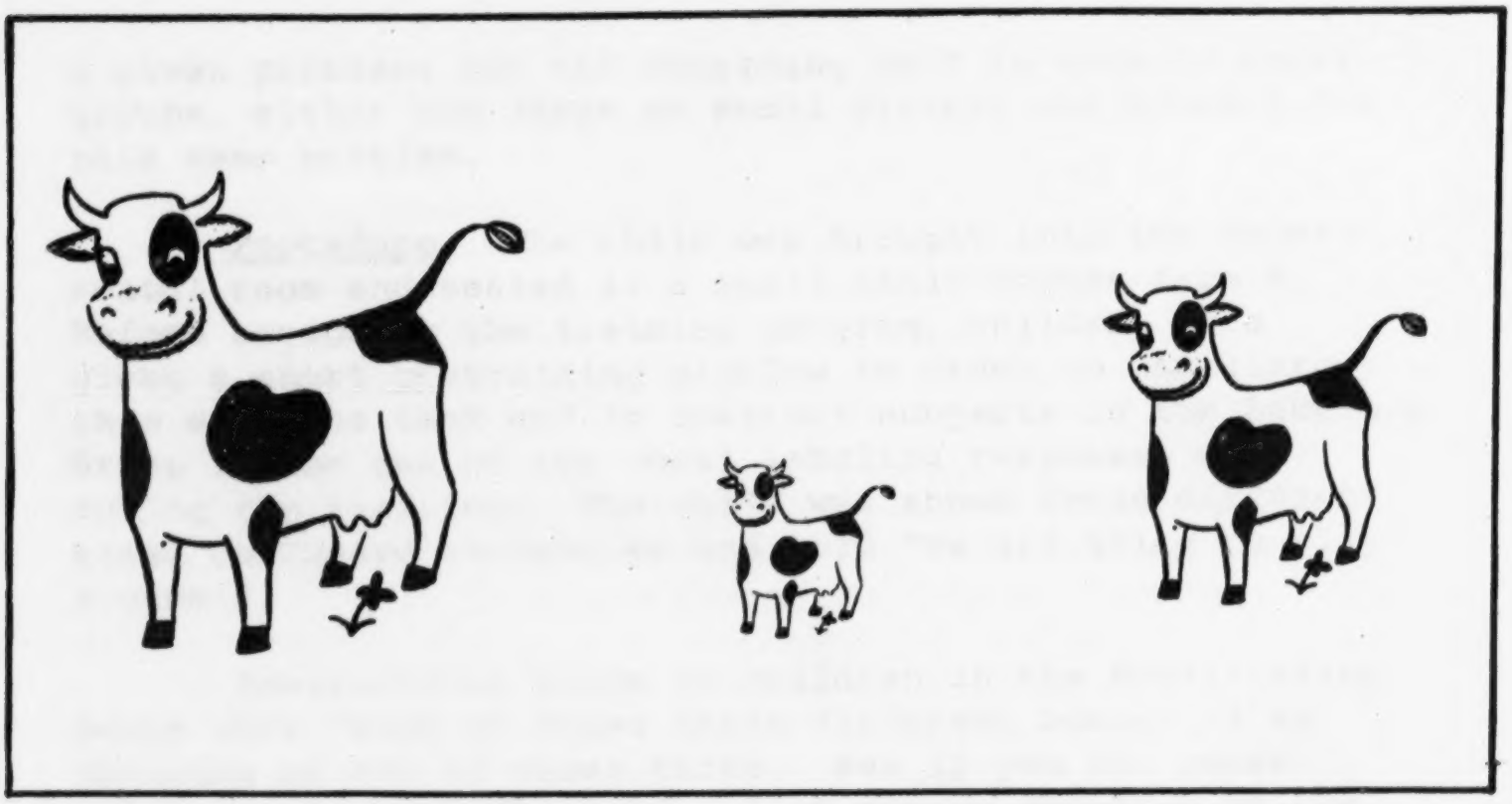
third was small. Sample stimulus cards which were presented during training and on the posttest are shown in Figure 1.

The child was presented with a series of problems on each of which he was required to select the correct sized picture by pointing to it. A problem involved four cards on each of which the same three different sized pictures appeared. For each problem one of the different sized stimuli was correct. On each card these three pictures were randomly rearranged.

On the first card of each problem, each subject was to guess until he selected the correct sized picture. On the second card, containing the same pictures in a different arrangement, the child was instructed to "Find the same one." If a subject failed to choose the correct stimulus, he was instructed to "Try again"; so that each child always selected the correct stimulus before E presented the next card. Each problem involved a different set of 3 pictures (e.g. snowmen, dogs, etc.); furthermore the correct sized stimulus for each problem was randomly determined. For example, on all 4 cards of problem 1, the Large cow was the correct picture; on problem 2, it was the Small Indian.

Design. The 60 children were randomly divided into a Labeling Group and a Non-labeling Group each containing 30 subjects. The average age of each group was 54 months. The Labeling Group was instructed to respond by saying aloud the concept label Big, Medium, or Little. The Non-labeling Group were given no instructions to respond aloud; they responded to the same question silently. E provided immediate knowledge of results for both groups by saying either "That's right" or "No" when the child pointed to a picture.

It was judged necessary to compare the results for those problems where the middle-sized stimulus was correct with problems where either the large or small stimulus was correct. Consequently, each of the two groups was randomly divided into two equal sub-groups. Therefore for half the vocalizing Ss and half the Non-vocalizing Ss, the middle-sized picture was correct on



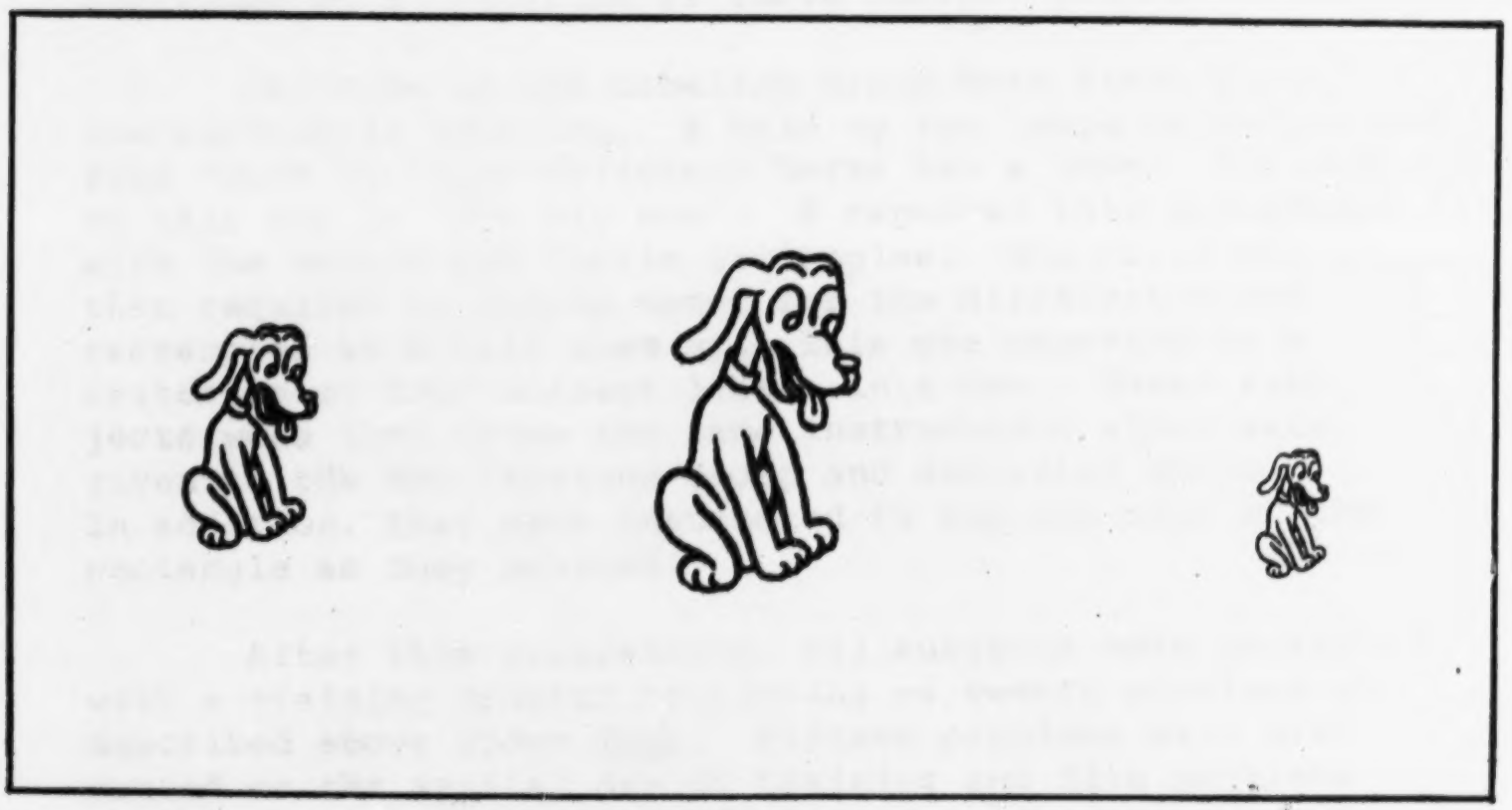


Figure 1. Sample Stimulus Cards Presented During Training and on Posttest on a Selective Learning Task Involving Size.

a given problem; for the remaining half in each of these groups, either the large or small picture was correct for this same problem.

Procedure. The child was brought into the experimental room and seated at a small table across from E. Before beginning the training program, children were given a short pretraining problem in order to familiarize them with the task and to instruct subjects in the Labeling Group in the use of the vocal labeling responses used during the training. The child was shown three different sized cardboard rectangles and told "We are going to play a game."

Instructions given to children in the Non-labeling Group were "Look at these three different boxes. I am thinking of one of these three. See if you can guess which one I am thinking of. I am always thinking of the same one. You guess." Children responded by pointing to one of the rectangles. The rectangles were rearranged in a new order after each correct choice. This was continued to a criterion of three correct choices in a row.

Children in the Labeling Group were first given instruction in labeling. E held up the large rectangle and said "Each of these different boxes has a name. The name of this box is 'The big one'. E repeated this procedure with the medium and little rectangles. The child was then required to supply names for the different sized rectangles as E held them up. This was repeated to a criterion of four correct labels in a row. These subjects were then given the same instructions which were given to the Non-labeling Group and described above. In addition, they were instructed to say the name of the rectangle as they pointed.

After this pretraining, all subjects were presented with a training program consisting of twenty problems as described above under Task. Fifteen problems were presented on the initial day of training and five problems on the following day. Each stimulus card was presented one at a time on a small metal stand placed directly in front of the child. When presented with a stimulus card, subjects in the Non-labeling Group responded silently to

the question "Which one am I thinking of?" by pointing to one of the three different sized pictures on the card.

The Labeling Group responded by saying the concept label Big, Medium, or Little aloud as they pointed to their choice. If a subject failed to vocalize the correct label, E said "What is its name?". Both groups on each frame responded by pointing and received immediate knowledge of results.

Posttest. Immediately following training all children were given the same posttest consisting of ten problems similar to those presented during training. For this posttest, the subjects in both groups were treated alike; no child was given instructions to speak or assistance in speaking. Scoring was based solely on the child's pointing response. Since the first picture card of each problem was used as an information frame, the child's performance on these initial frames was not included in his score. The highest possible score on the posttest was 30 points, 3 points for each of the 10 problems. A comparable score was calculated for the performance of each child during training. Since here the initial frames were also not counted, the highest possible score for this performance during training was 60 points.

Results

Table 3 shows the mean number of total errors for both groups. As Table 3 indicates, the Non-labeling Group had a greater mean number of errors during training as well as on the posttest than did the Labeling Group. The mean number of errors for both groups are presented graphically in Figure 2. A repeated measures analysis of variance for the posttest is shown in Table 4. The Newman-Keuls Procedure was used to test the differences in means. In comparison with the Labeling Group, the subjects in the group not receiving labeling training were found to have a significantly greater number of errors during training ($p < .01$) as well as on the posttest ($p < .05$).

Turning now to the difference in item types, Table 5 presents the mean number of errors on two types of items: (a) medium size (b) large and small size, as correct responses. Figure 3 illustrates the difference of the

TABLE 3. Mean Number of Total Errors on a Selective Learning Task Involving Size for Labeling and Non-labeling Groups.

	Training			Posttest		
	Mean	SD	Mean Diff.	Mean	SD	Mean Diff.
Labeling Group (N = 30)	6.5	5.6		4.1	2.6	
			5.8**			1.8*
Non-labeling Group (N = 30)	12.3	7.5		5.9	3.4	

*p < .05
**p < .01

TABLE 4. Analysis of Variance of Posttest Scores on a Selective Learning Task for Labeling and Non-labeling Groups with Two Types of Items.

Source of Variation	SS	df	MS	F
Between Subjects	299	59		
Treatments	25.2	1	25.2	5.3*
Subjects Within Groups	273.8	58	4.7	
Within Subjects	145	60		
Size	35.2	1	35.2	19.2**
Treatments X Size	3.8	1	3.8	2.1
Error Within Groups	106.1	58	1.8	

*p < .05
**p < .01

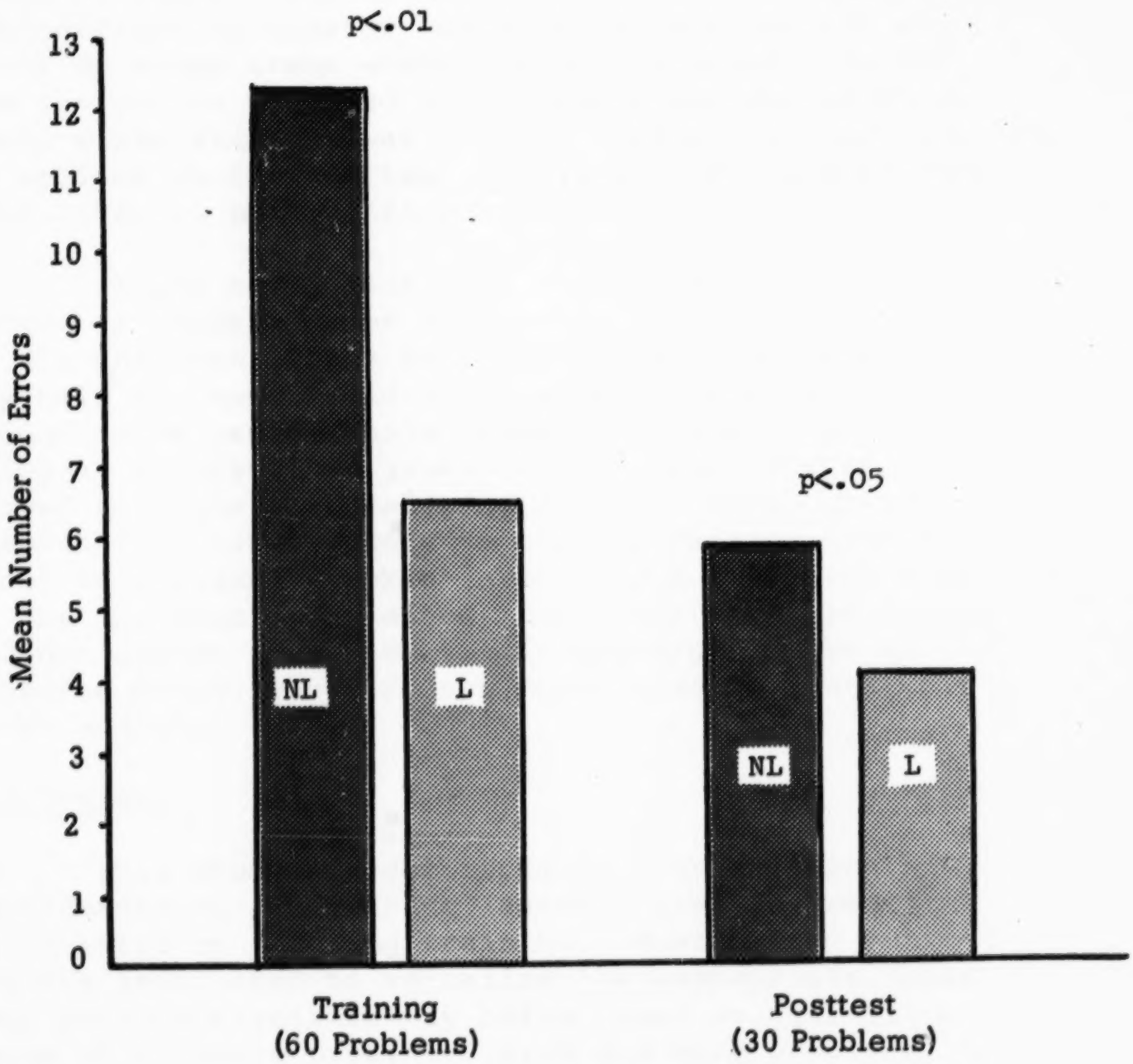


Figure 2. Mean Number of Total Errors (Medium, Large, and Small) by Labeling and Non-Labeling Groups During Training and On Posttest On a Selective Learning Task Involving Size.

Based on 30 cases per group.

mean number of errors for all subjects on these two types of items. The Newman-Keuls Procedure revealed a significantly greater number of errors for all subjects on those items where the medium sized stimulus was correct as compared with items where the large or small sized stimulus was correct during training ($p < .001$) as well as on the posttest ($p < .001$). No interactions were found to be significant.

It was not possible to obtain any accurate record of verbalization during the posttest on the part of the children in the Labeling Group. Approximately one-half of these children vocalized the problem loud enough to be heard, while others appeared to be vocalizing at an inaudible level. Still other children showed no signs of vocalizing at all. These vocal responses differed widely in clarity ranging from a grunt to a clearly spoken label. In a few cases some of the children spoke aloud, but their vocal responses did not appear to be relevant. Children in the Non-labeling Group, who were not instructed to label, never spoke audibly.

Conclusions

This study has demonstrated that children's performance on a selective learning task is greatly facilitated by labeling training. Where young children are instructed to verbalize the appropriate label, they perform significantly better than an equivalent group of children presented with the same problems, but not instructed to speak aloud. Although the effect was more pronounced during training, even on the posttest where no instructions to verbalize were given, children in the Labeling Group showed reliably superior performance.

TABLE 5. Mean Number of Errors for All Subjects on Two Types of Items: (a) Medium Size (b) Large and Small Size, as Correct Responses.

	Training			Posttest		
	Mean	SD	Mean Diff.	Mean	SD	Mean Diff.
Items where correct response was medium size	5.6	4.5		3.0	2.2	
			1.8***			1.1***
Items where correct response was either large or small size	3.8	3.4		1.9	1.6	

***p <.001 (Based on the Newman-Keuls test)

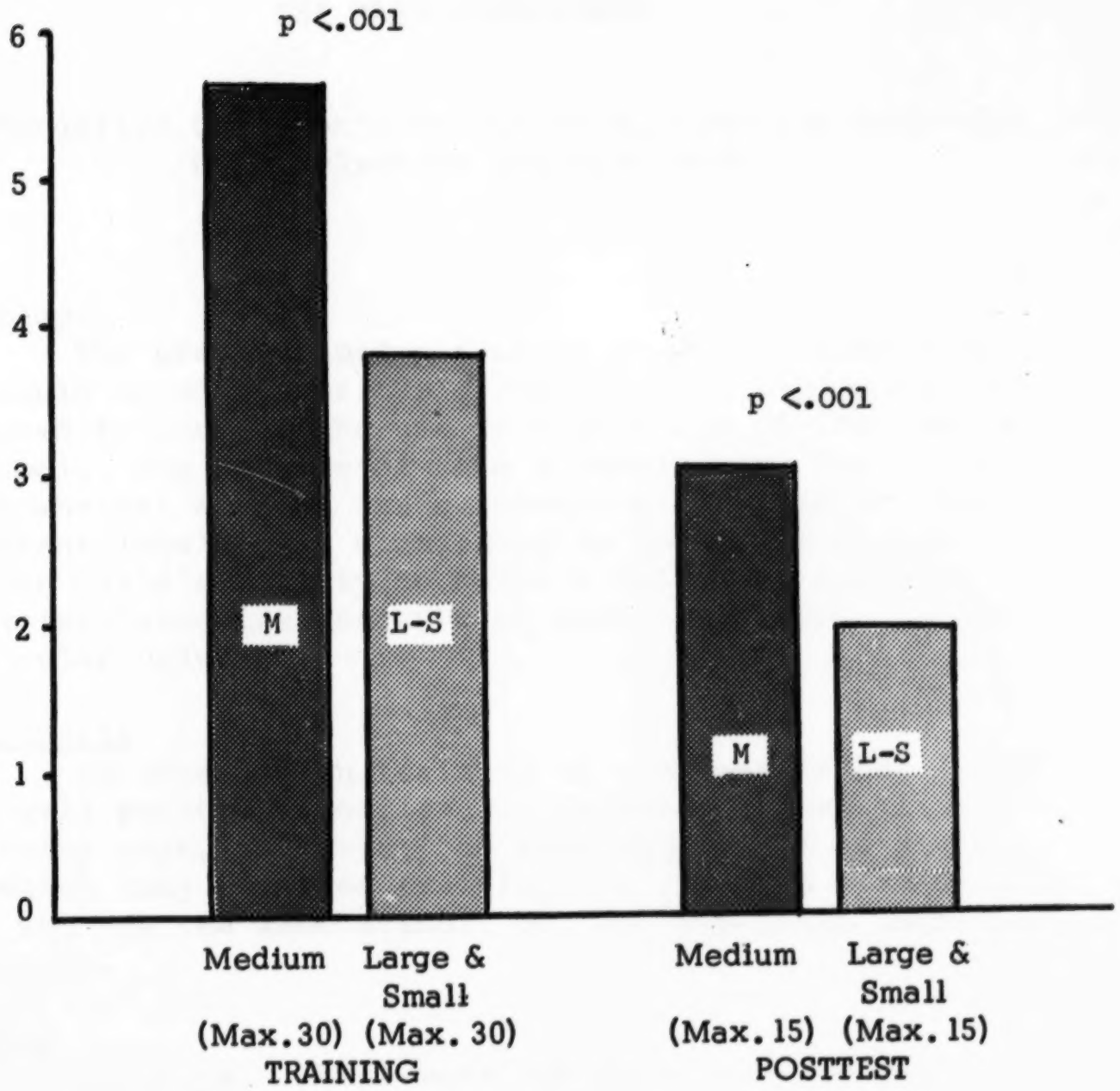


Figure 3. Mean Number of Errors for All Subjects on Two Types of Items: (a) Medium Size, (b) Large and Small Size, as Correct Responses During Training and on Posttest. Based on 60 Cases.

THE MAIN EXPERIMENT

Kindergarten Children's Use of Vocal Labeling Responses On a Selective Learning Task

Problem

The previous pilot studies have indicated that it would be most profitable for the main instructional program to involve the use of a self-cue in the form of a label. The purpose of this investigation was to determine whether a short instructional program in the use of relevant labels will significantly enhance a kindergarten child's ability to solve a selective learning task involving the concepts of size, thickness, length, and color value.

Hypothesis

Children given training in relevant verbal labeling will perform significantly better on a selective learning task, involving the same dimensions as those on which they received training, as compared with children who see the same stimuli but are not given labeling training.

Method

Subjects. There were 100 five-year-old children selected from six kindergarten classes of a Central Los Angeles elementary school. Attrition due to absenteeism (because of a chicken pox epidemic) brought the final N down to 72 subjects. The children came from lower socioeconomic class homes and were predominantly Negro. Their mean MA was 61 months.

Apparatus. The apparatus consisted of ten individual three-sided booths, each equipped with a pair of earphones, a microphone, and a multiple-choice response panel. The panel contained a row of three buttons. The children viewed a central screen which was visible from each booth. 35-mm. slides were projected by a Kodak

Carousel Slide Projector. Through individual earphones children heard the commentary from a Wollensak stereo tape recorder which also controlled the presentation of slides and operation of the apparatus.

After the children were given task instructions, they had an interval of seven seconds in which to respond to multiple-choice questions by pressing buttons, knowledge of results being supplied by a green light or red light. A Clary data recorder was used to record the multiple-choice responses for each child on punched paper tape before a new cycle was initiated. The apparatus used for each child is shown in figures 4 and 5.

An instantaneous visual display of the responses of all the children to each item appeared on the master control panel, as well as the correct answer for each item. The apparatus was arranged so that the entire program was presented automatically thus assuring high replicability from one group of ten children to the next. The equipment at the control panel with a view of the arrangement of booths for the instructional program is shown in Figures 6 and 7.

Task and Materials. Each child was shown a sequence of 35-mm. color slides, each slide consisting of three pictures of the same object which were alike in all respects except that they differed in either size, thickness, length, or color value. (e.g. large, medium-sized, and small). Sample slides which were presented during training and on the posttest are shown in figures 8 to 11.

The child was presented with a series of problems on each of which he was required to select the correct picture by pressing the button corresponding to that picture. A problem involved four slides on each of which the same set of three different pictures appeared for all four slides. On each slide these three pictures were randomly rearranged. For each problem the same one of these pictures was "correct".

Figure 4. The Apparatus Used for Each Child.

Figure 5. Children in Booths Watching Screen.

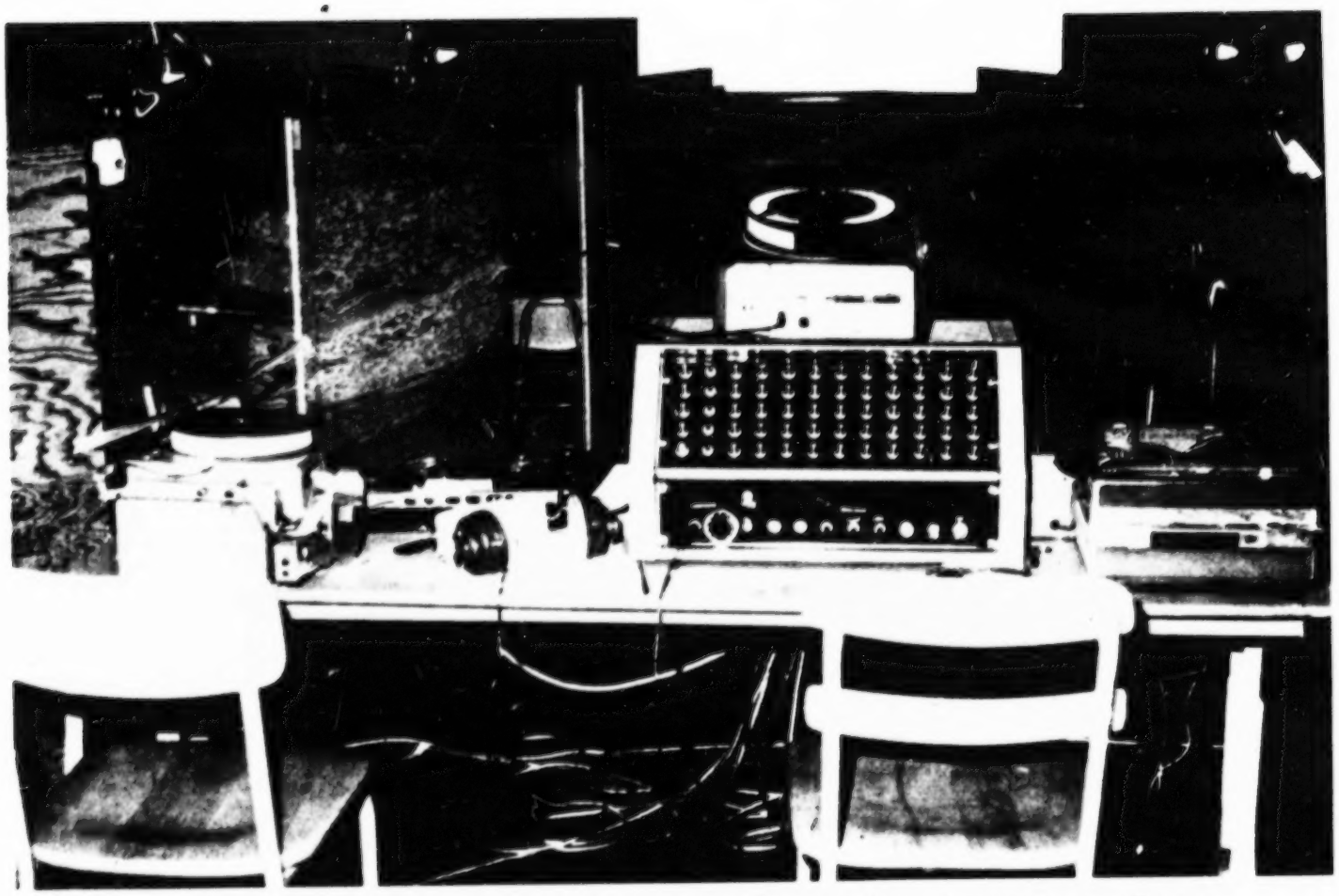


Figure 6. Equipment at Control Panel (including Projector, Tape Recorder, Paper Tape Punch, and Monitoring Panel) With View of the Arrangement of Booths for Instructional Program.

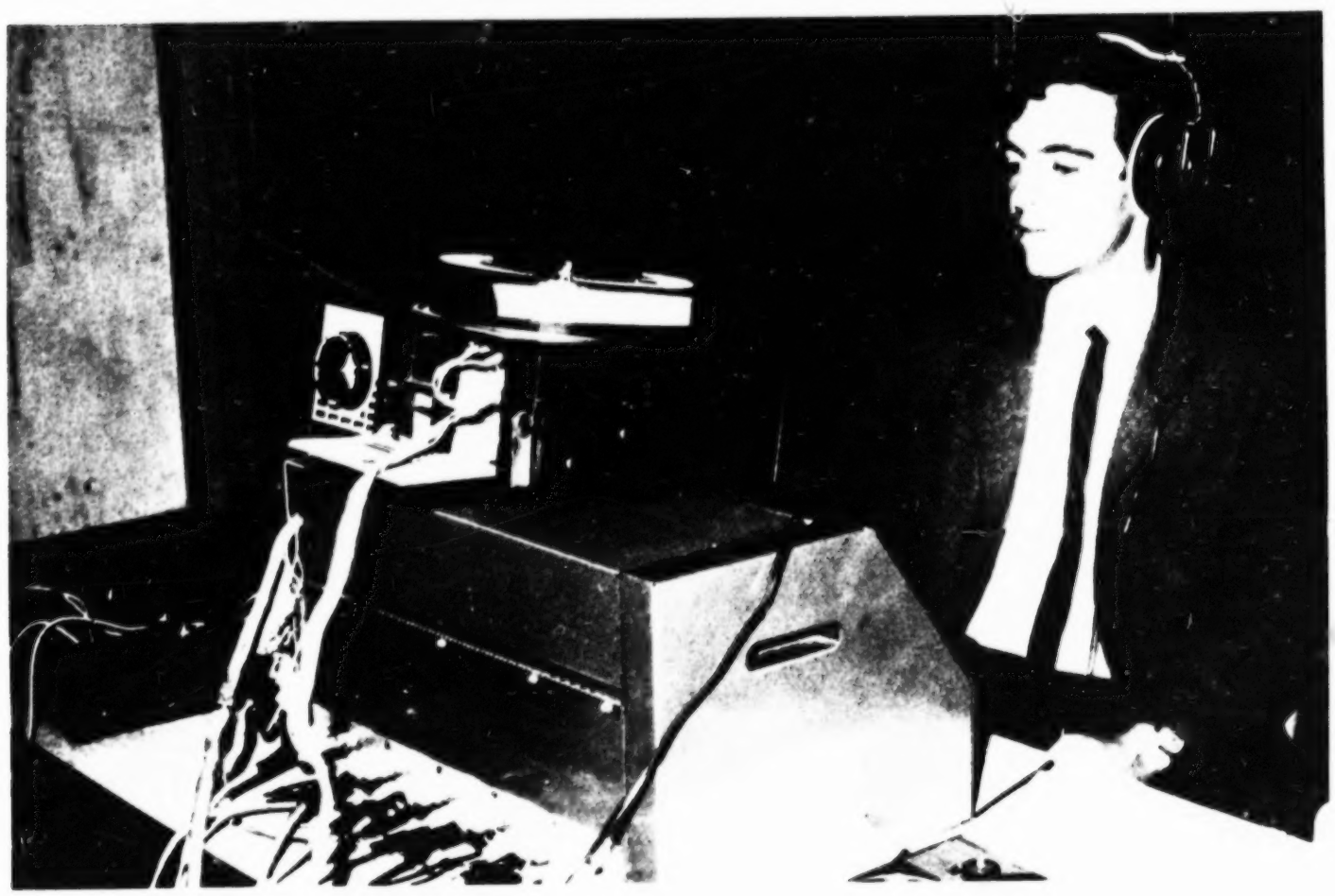


Figure 7. Experimenter at Control Panel.

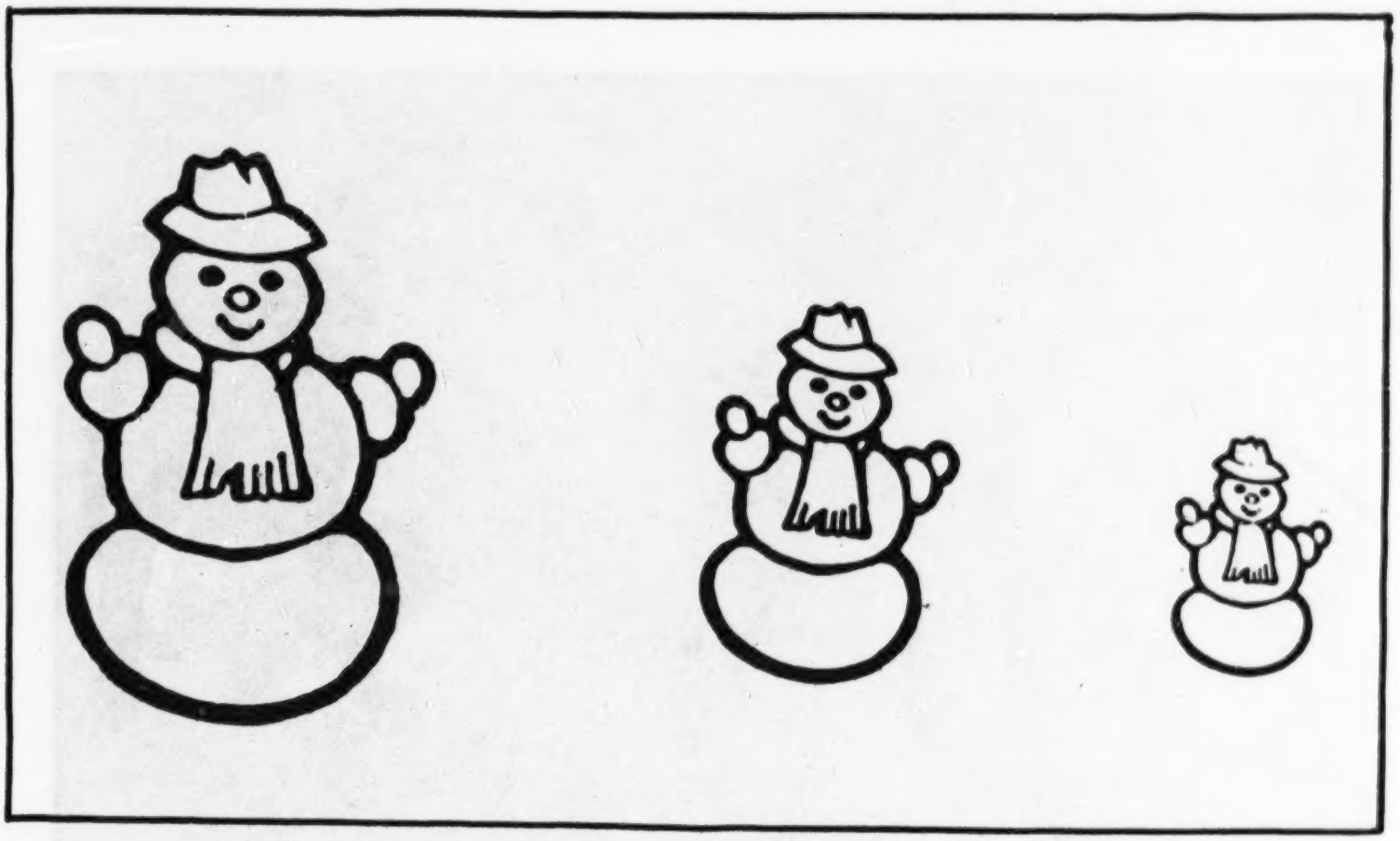


Figure 8. Sample Stimulus Cards for Size Dimension Presented During Training and on the Posttest on a Selective Learning Task.

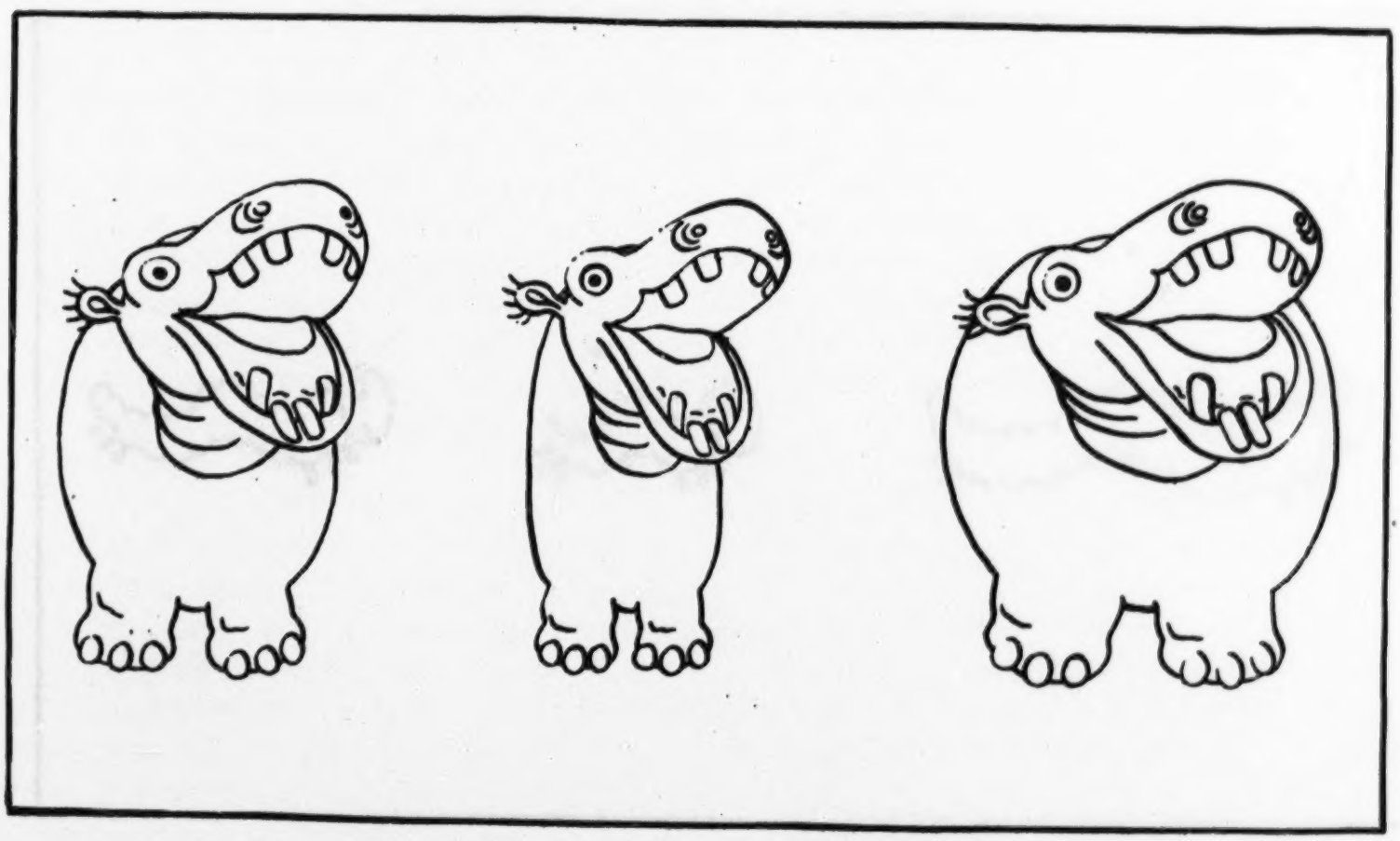


Figure 9. Sample Stimulus Cards for Thickness Dimension Presented During Training and on the Posttest on a Selective Learning Task.

Figure 10. Sample Stimulus Cards for Color Dimension Presented During Training and On the Posttest On a Selective Learning Task.

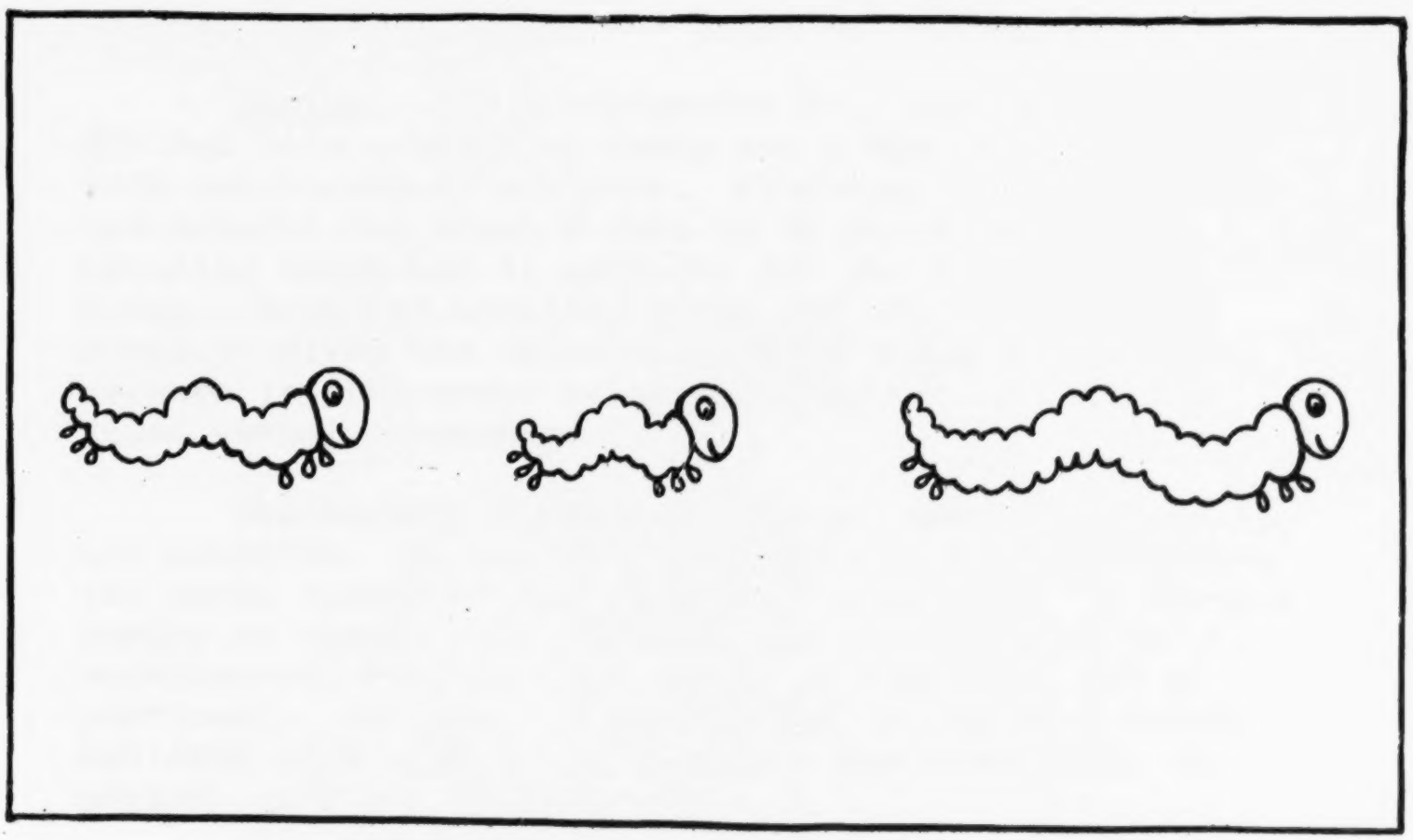


Figure 11. Sample Stimulus Cards for Length Dimension Presented During Training and On the Posttest On a Selective Learning Task.

The first slide of each problem instructed the child as to the correct picture for that problem. He was then shown a second slide containing the same pictures in a different arrangement. S was instructed to "Find the same one". The child was required to press the button which corresponded with the correct picture. If he responded correctly, the button which he pressed turned green. If the child pressed incorrectly, a red light went on in a button in the lower center of the panel. If this happened, the child had been instructed during the Button Press Training to "Get a green light." by pressing the "red-light" button and selecting another response; so that he was able to select the correct stimulus before the next slide was presented. The colored lights within the buttons provided the child with immediate knowledge of results.

Problems differed with respect to the subject of the stimulus picture (e.g. snowmen, dogs, etc.) as well as the dimensions along which the pictures differed (i.e. size, thickness, length, or color value). The correct picture for each problem was randomly determined. For example, on the third day of training, when the three pictures on a slide differed in thickness, for all four frames of Problem 1, the Fat cook was the correct picture; on Problem 2, it was the Medium pig.

Design. 100 kindergarten children were randomly divided into a Labeling Group and a Non-labeling Group each containing 50 subjects. Attrition due to absenteeism brought the final N down to 41 subjects for the Labeling Group and 31 subjects for the Non-labeling Group. Both the Labeling Group and the Non-labeling Group received the identical visual program, the difference in treatments being entirely in terms of the taped verbal commentary.

The Peabody Picture Vocabulary Test was given to all subjects. It had been originally planned to establish three levels of MA. However, because of the reduced number of cases, this variable was not included in the experimental design. The number of cases was not proportional. Instead, it was decided to use as a second variable item type, a factor which had been found important in Pilot Study No. 3.

The Labeling Group was instructed to respond by saying aloud the relevant concept label for a given stimulus immediately before pressing the button for that stimulus. The labels subjects were instructed to vocalize corresponded to the dimensions along which the stimulus pictures varied. For example, for pictures differing in size, the labels taught were Big, Medium, and Little; for thickness the labels were Fat, Medium, and Thin; for length, Long, Medium, and Short; and color value, Dark, Medium, and Light.

The Non-labeling Group responded to the same questions silently. However, both groups on each frame responded by button pressing, receiving immediate knowledge of results. On one-third of the problems, the correct picture was the intermediate sized stimulus; while problems having pictures representing the extremes within a dimension equally divided the remaining two-thirds of the problems.

Procedure. All instructional programs were presented by means of the auto-instructional equipment and materials described above. Training programs were provided for 15 minutes per day over an eight-day period, and administered to groups varying between five to ten children at a time. There were twelve problems per day. The eight-day program consisted of three phases: orientation and button press training, selective learning task training, and testing. These three phases are described below.

(1) Orientation and Button Press Training. On the first day of instruction the children were brought into the experimental room accompanied by their teacher. The children put on earphones through which they heard popular music. This familiarized subjects with the instructional setting. After five minutes, the children returned to their classroom.

Later that same day the subjects returned for instruction in the use of the multiple-response panel on which were mounted three buttons. The child was seated at an instructional booth by E. He heard one minute of popular music. The first slide was a picture

of a clown. Each child heard the following commentary: "Hello boys and girls. This is Happy the clown. Raise your hands to show that you can hear me. We are going to play a game. Look at the buttons on your control box. We are going to press these buttons in our game."

The children were shown a series of 41 slides each of which was divided into three boxes. One of the initial slides shows two of these boxes empty and a cat is in the third box which is the box nearest to the door of the experimental room. The child is instructed "Look at the screen. See the three boxes. There is a cat in one of the boxes. Point to the cat. The cat is in the box on the door side. Show me that you know which box the cat is in. Push the button that is on the same side as the cat. See the button light up. The green light shows that you are right." Frames progressed in difficulty until each of the three boxes contained an object. In frame 40 the boxes contained a pail, star, and ball respectively. Instructions were "Press for the ball."

The second day of instruction consisted of 48 frames similar to frame 40 described above. During the first two days of instruction, all children received identical training. At the end of day two, subjects were randomly divided into a Labeling Group and a Non-labeling Group.

(2) <u>Selective Learning Task Training</u>

On the third day of instruction, all children were presented with a training program consisting of twelve problems described above under Task. The first slide of each problem consisted of three pictures which were alike in all respects except that one was large, a second was middle-sized, and a third was small. Above one of the different sized pictures was an arrow.

The instructions for the Non-labeling Group were "I'm thinking of the picture with an arrow over it. Push the button for the picture the arrow points to." The child was then shown a slide identical to the first except that the different sized stimuli were

randomly rearranged and there was no arrow. Each child was instructed to "Press for the same one. Get a green light." The third and fourth frames of each problem were identical to the second except for the rearrangement of the pictures. The subject was then shown a blank slide followed by another problem which differed from the first with respect to the subject of the stimulus picture as well as the correct sized stimulus. After the twelve problems were completed, the child was shown the clown slide and heard the commentary "You boys and girls did fine. See you tomorrow."

In addition to the above, subjects in the Labeling Group were given training in relevant verbal labeling. After the child made the button press response to the first slide, he heard the correct verbal label for that problem through his earphones (e.g. "Its the Big one." The second slide was then presented. The child was instructed to say aloud the correct label into his microphone (e.g. "Big). A system of voice relays was used to provide reinforcement for this vocal response. When the child spoke into his microphone, a yellow light in the lower center of his response panel turned on. He was required to "Get a yellow light" in order to activate his response panel so that he could "Get a green light." Since children in this treatment group were required to produce both a vocal and a button press response as compared with the Non-labeling Group responding by button press only, the Labeling Group was given an interval of nine seconds in which to respond. The vocal response was not required on the first frame of each problem. The labels with which the children were given training for these pictures differing in size were Big, Medium, and Little.

The training programs presented on the fourth, fifth, and sixth days of instruction were similar to that of the third day described above except for the dimensions along which the pictures differed and the labels with which subjects in the Labeling Group were given training. On the fourth day pictures differed in thickness and the labels were Fat, Medium, and Thin.

Stimuli on the fifth day differed in values of the same color with labels being Dark, Medium, and Light. Stimuli presented on the sixth day differed in length with the Labeling Group taught the labels Long, Medium, and Short to the appropriate pictures.

The seventh and eighth days of instruction presented all children with a selection of problems similar to those presented during days three to six. The format remained the same with the exception that the training program for the Labeling Group faded the yellow reinforcing light for speaking. The labels provided by the taped commentary were faded over the last two instructional lessons.

(3) Posttest

On the ninth day of this instructional program, subjects were presented with a posttest consisting of twelve problems similar to those on which they had received training. Each of the four concepts on which the children had been trained were represented. While the types of problems remained the same, the subject of the stimulus pictures for each problem had not been previously seen by the child. The number of frames involved in each problem was increased to five.

For this posttest, the subjects in both groups were treated alike; no child was given instructions to speak or any assistance in speaking. Furthermore, no reinforcement for speaking was provided by the yellow reinforcing light. Since the first frame of each problem was used as an information frame, the child's performance on these initial frames was not included in his score. The highest possible score on the posttest was 48 points, 4 points for each of the twelve problems.

RESULTS

Looking at the performance of the two groups during training, we see in Figure 12 that there was little difference in the mean number of correct responses on consecutive training days between Labeling and Non-labeling Groups. Since the SDs were large and the means so close, it was not judged necessary to test the significance of the difference between the means.

The results of the posttest are shown in Table 6 which shows the mean number of correct responses for both groups. An analysis of variance on these posttest data is shown in Table 7. This table shows that no support was obtained for the main hypothesis that those children given training in relevant verbal labeling would perform significantly better on a posttest as compared with children who saw the same stimuli but were not given labeling training. No interactions were found to be significant.

As is indicated in the analysis of variance in Table 7, there was a significant main effect of item type on the posttest. The means and SDs on the three different types of items are shown in Table 8. The Newman-Keuls Procedure was used to test this effect of item type for all subjects combined. A significantly greater number of correct responses was found on those items where either of the extremes of a stimulus dimension (e.g. Big or Little) were correct as compared with items where the medium sized stimulus was correct ($p < .01$).

Were these negative results attributable to the fact that the Labeling Group failed to verbalize on the posttest? It will be recalled that attempts were made to slowly remove the prompts for verbalizing so that the children would continue to vocalize on the posttest. It was not possible to obtain any accurate record of verbalization during the posttest; however

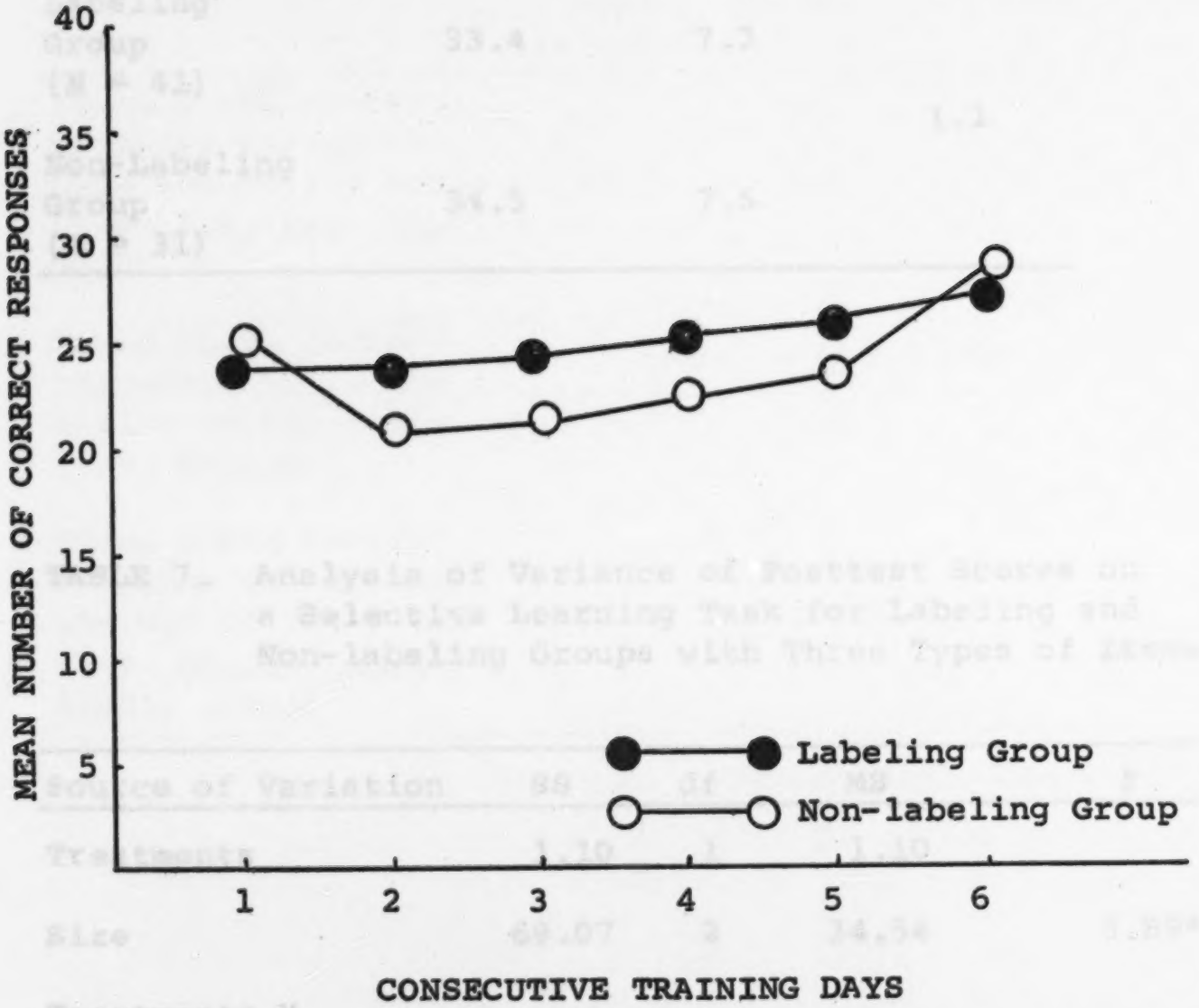


Figure 12. Mean Number of Correct Responses During Training On a Selective Learning Task for Labeling and Non-labeling Groups.

TABLE 6. Mean Number of Correct Responses on the Posttest of a Selective Learning Task for Labeling and Non-labeling Groups

	Mean (48 max.)	SD	Mean Diff.
Labeling Group (N = 41)	33.4	7.3	1.1
Non-Labeling Group (N = 31)	34.5	7.5	

TABLE 7. Analysis of Variance of Posttest Scores on a Selective Learning Task for Labeling and Non-labeling Groups with Three Types of Items

Source of Variation	SS	df	MS	F
Treatments	1.10	1	1.10	
Size	69.07	2	34.54	3.89*
Treatments X Size	.06	2	.03	
Within Cell Error	1688	210	8.88	

*$p < .05$

TABLE 8. Mean Number of Correct Responses on the Posttest for all Subjects on Three Types of Items: (a) High End of the Scale (b) Middle of the Scale (c) Low End of the Scale, as Correct Responses.

	Mean (16 max.)	SD	Mean Diff.
Items where correct response was on the high end of the scale (i.e. Big, Fat, Long, Dark)	12.4	1.3	
			3.2**
Items where correct response was in the middle of the scale (i.e. Medium)	9.3	3.2	
			2.9**
Items where correct response was on the low end of the scale (i.e. Little, Thin, Short, Light)	12.1	2.9	

**$p < .01$ (Based on a Newman-Keuls test)

it did appear that many of the children in the Labeling Group were vocalizing. Children in the Non-labeling Group, who were not instructed to label, never spoke audibly.

DISCUSSION

In this series of studies it was demonstrated that in a two-day training period involving a homogeneous set of training materials, children's performance on a selective learning task is facilitated by labeling training. The materials involved a consistent set of labels (i.e. Big, Medium, and Little), and the children given overt training with these labels over this two-day period proved to be significantly superior to a group of children who saw the same stimuli but were not given the labeling training. The superiority of the overt Labeling Group cannot be attributed simply to the fact that these subjects were given a new label to use. If anything, the differences were larger on the problems where the correct answer involved very familiar labels (e.g. Big or Little) rather than on problems for which the relatively unfamiliar label Medium was appropriate.

The finding of the two-day study was not verified when the instructional treatment was expanded to include several different types of materials. In this longer study, children were required to use four sets of labels (i.e. Big, Medium, and Little; Fat, Medium, and Thin; Long, Medium, and Short; and Dark, Medium, and Light) on materials differing in size, thickness, length, and color value respectively and no superiority was demonstrated.

There may be a number of reasons for the difference in results between these two studies. In the first study only one set of labels was involved, whereas in the second study there were four sets. The children in the Labeling Group may have been confused as to which label they were required to use for a given stimulus. For example, the children were instructed to respond with the labels Fat or Long to pictures which the child could easily have labeled Big. In addition, to the stimuli to which these subjects were instructed to respond with

the labels Thin, or Short, the label Little also applied. The label Medium was used with the intermediate sized stimulus for all four stimulus dimensions. Not only was the child taught in the experiment to respond with Big to similar stimuli but this response may have been supported in his everyday life. The child's previous experience therefore may have interfered with much of the labeling training he was being given in the experiment. The Non-labeling Group were not exposed to this kind of interference; These children were not required to learn any labels at all.

It is possible, of course, that this interference may have been due to an insufficient amount of labeling training. As Reese (25, p.66) suggests: "...poorly learned names, whether distinctive or similar, will produce interference; well learned names, whether distinctive or similar, will produce facilitation." A longer period of training may be desirable.

It is also possible that the difference in the two investigations is attributable to the difference in ages of the subjects. In Pilot Study No. 3 only four-year-old children were used, whereas the main experiment was conducted with five-year-olds. There also may have been some differences in the socioeconomic level of the two populations, but this is probably not significant. The finding that language may be interfering as well as facilitating is substantiated by the results in Pilot Study No. 2 where those children who spoke aloud a relevant sentence in an inferential type problem performed significantly worse than children who saw the same stimuli but did not speak.

Another possible reason for the difference between the two studies may be the method in which the children were required to respond. Because of the use of electronic equipment, children in the main experiment did not point directly to the picture; they pressed buttons to indicate their choices. The effect of the locus of response is an area in which little research evidence is available.

The fact that a significantly greater number of errors were made on those items where the intermediate size stimulus was correct as compared with either of the extremes seems to agree with other findings. Hicks (6), for example, found that young children tend to confuse the intermediate size stimulus with the larger or smaller stimuli.

CONCLUSIONS

This study has indicated that four-year-old children's performance on a selective learning task is facilitated by instructing children to say aloud the appropriate labels. The finding applied to a task where: (1) a single set of labels is used throughout, (2) the instructional program involves pictures of relational concepts within a single dimension.

In a longer study with a slightly older population, no facilitation was demonstrated by having children speak appropriate labels aloud. In this second study, however, the children used several sets of pictures of different but related dimensions.

A clear finding from both of these studies was that children found much more difficult those items where the correct picture was the intermediate sized stimulus rather than one of the extremes. It was suggested that this finding was attributable to the fact that children found the intermediate sized stimulus more difficult to label and respond to in both investigations. This was true in the second investigation even though the word Medium was a consistent label on each of the four dimensions.

The general approach of presenting the child with pictorial stimuli requiring both vocal and multiple-choice responses seems to hold promise for future investigations. The project also demonstrated the possible deleterious effects of overt verbalizing. With the disjunctive type problems where the child was required to make an inference, overt verbalization clearly interfered with the child's performance. In future studies of the role of labeling in problem solving, greater attention should be given to (1) the interfering effects of labels, (2) the learning of

each set of labels to a criterion before a new set is introduced.[1] In preparing instructional programs and future research studies this project has demonstrated that under certain circumstances, having the young child speak aloud key words and phrases is an effective procedure in problem solving. In other situations however, especially where a variety of similar labels are used, this very act of speaking may be non-facilitating or even interfering. Studies designed to throw light on this question will contribute to our understanding of the role of language as a problem solving tool.

[1]As a sequel to this contract research, an improved study along the lines suggested is being conducted. The new experimental design has been developed to overcome some of these deficiencies.

SUMMARY

How the Language of Kindergarten Children May be Developed for Use in Problem Solving

The central problem of this investigation was to assess the value of having young children speak aloud key words or sentences during a problem solving task. The effect of such training was assessed by presenting new problems with no instructions to verbalize.

In a two-day investigation, 60 four-year-old children were trained individually to select the correct one of three pictures differing only in size. The children were divided randomly into a Labeling Group and a Non-labeling Group. Children in the Labeling Group were required to overtly verbalize relevant labels during this selective learning task. They performed significantly better during training and on a posttest than children who saw the same stimuli but were given no labeling training.

This finding was not verified in an eight-day investigation where the presentation of stimulus materials and verbal instructions was electronically controlled. Seventy-two five-year-old children were divided randomly between Labeling and Non-labeling Groups and given training on a selective learning task involving materials differing in size, thickness, length, and color value. Children in the Labeling Group were required to learn four sets of relevant labels. On the posttest, where no children were instructed to verbalize, no differences in performance were found between the Labeling and Non-labeling Groups. All children performed consistently worse when the intermediate size picture was the correct stimulus. A pilot study also demonstrated the possible interfering effects of language. The causal factors for the facilitation or interference of language during problem solving were discussed.

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APPENDIX A INSTRUMENT: Sample Story Problem From Instructional Program in Pilot Study No. 1

Problem No.	Frame No.	Picture on Card	Commentary	Expected Student Response: Multiple Choice
6	1	Boy (He is looking).	"Here is Tom. He is looking for his toy."	
	2	An airplane and a sailboat in a sandbox. The back of a boy's head looking at them.	"Tom sees his toy."	
	3	A green sailboat and a red airplane in the sandbox.	"Here is a sailboat and an airplane."	
	4	A red airplane.	"The airplane is not Tom's."	
	5	Two toys only. (1) Sailboat (2) Airplane	"Which toy is Tom's? You point."	(1)

APPENDIX B INSTRUMENT: Sample Story Problem From Instructional Program in Pilot Study No. 2

Problem No.	Frame No.	Picture on Card	Commentary	Expected Student Response: Spoken	Expected Student Response: Multiple Choice
7	1	Hammer on Table.	"Here is a hammer made of sponge rubber."		
	2	Sheet of glass.	"Sponge rubber will not hurt glass."	"Sponge rubber will not hurt glass." *	
	3	Three drinking glasses with identical hammers next to each.	"Here are three glasses and three hammers."		
	4	A hammer about to strike each of the glasses.	"Look. Someone is hitting each of the glasses with a hammer."		
	5	Hammer on Table.	"Sponge rubber will not hurt glass."	"Sponge rubber will not hurt glass." *	
	6	Three glasses only. (1) Has piece missing (2) Is cracked (3) Not damaged	"Which glass was hit with a sponge rubber hammer?"		(3)

* Indicates spoken response for subjects in Verbal Group only.